

## Technical Evaluation for

### STEREO Phase B Study

This proposal is in response to a Cost Plus Fixed Fee procurement under [REDACTED] contract NAS5-[REDACTED]. The proposed cost totals \$15,322,886 over FY00 and FY01, with the cost representing 111,709 staff hours of labor, plus travel and direct costs.

Detailed estimates were provided by Abby Harper, STEREO Mission Manager, and past Observatory Manager of the Tropical Rainfall Measurement Mission (TRMM), an in-house GSFC program. TRMM has similarities to STEREO in its bus complexity as well as in its use of heritage hardware for major subsystem components. Our recommendation was the result of a review of TRMM manpower charges and engineering judgement.

### INTRODUCTION

The STEREO mission is the third in a line of solar and magnetospheric probes managed at the GSFC. Because of their specific expertise demonstrated on ACE, NEAR, and other low cost spacecraft, a JOFOC was initiated to have [REDACTED] perform the formulation studies for STEREO. This procurement was advertised in the Commerce Business Daily and after an evaluation of the responses, an RFP was prepared.

In order to better parallel the approach for the instrument Announcement of Opportunity studies, this formulation study has been divided into two parts, Phase A, mission definition, and Phase B preliminary design. This proposal is in response to an RFP for the Phase B portion of the study.

### EVALUATIONS AND DISCUSSIONS

On the whole, the proposed number of hours is somewhat higher than I expected for the level of effort, but not out of bed with industry norms. Generally, we expect the formulation studies to cost roughly 10% of the development costs. The basis for this is a presentation by Werner Gruhl (Office of the Comptroller, NASA HQ 1985) demonstrating a correlation between formulation study work and final cost overruns. We expect to spend \$[REDACTED]M in Phase B study work on STEREO, based on a \$[REDACTED]M implementation cost. When combined with Phase A costs, [REDACTED] proposal is 12% of implementation cost, representing a conservative estimate.

The proposed distribution of labor categories is appropriate. As a result, labor categories can be redistributed with the proposed proportions for functions where I recommended reduced hours.

#### Staff Hours

	Proposed	Recommended
Project Management	16280	16280
Payload	5890	5328
Spacecraft Bus	72112	67665
Integration and Test	10671	8895
Science and Outreach	2664	888
Prelaunch ground Data system	3722	3722
Education and Outreach	370	370
TOTAL	111,709	103,148

#### Non Labor Costs

	Proposed	Recommended
Special Test Equipment	\$226,372	\$226,372

### Evaluation of Specific WBS elements:

#### WBS 100 – Project Management, systems engineering/mission design/performance assurance

	Proposed	Recommended
Staff Hours	16280	16280
Travel	\$53,046	\$53,046
MODC \$	\$22,366	\$22,366

This section covers standard project management functions such as Project Manager, secretary, scheduling and budget support as well as export licensing management. Three FTEs are planned for these standard functions, a reasonably lean estimate.

The majority of the hours are projected for systems engineering, performance assurance and analysis. Systems engineering support is appropriate. This team supports fault tree analysis, failure modes effects analysis, the verification matrix, software management planning among many other things. My only concern at this point is that, knowing the team currently assigned, I have seen no movement towards securing the appropriate engineers to fulfill the requested manpower level. I am particularly interested in ensuring that the function for overall software systems engineering is covered.

Travel numbers translate to 26 trips (I estimated \$2000 per trip) for 9 people which I would consider excessive for this stage of the project. However, because this is in the project management function, I will accept the numbers and assume that this value includes some margin for travel in general for the project team.

#### WBS 200 – Payload

	Proposed	Recommended
Staff Hours	5890	5328
Travel \$	\$10,862	\$10,862
MODC \$	\$13,150	\$13,150

The 5890 hours translates to 3.3 full time equivalents (FTEs) for payload support. The GSFC project team is currently manned at 1 FTE, ramping up to 3 during the first months of Phase B. We would not expect [REDACTED] instrument support to be greater than our own. With the additional support from the GSFC project team, I would expect 2 FTE for instrument support from [REDACTED] for instrument interface managers plus 1 for the emulator work.

[REDACTED] may have assumed some additional hours in this category for subsystem support to instrument reviews, etc. I however, feel that the subsystem support describe in WBS 300 is adequate for this task and need not be supplemented.

Travel is reasonable for this function.

#### WBS 300 – Spacecraft bus

	Proposed	Recommended
Staff Hours	72112	67665
Travel \$	\$122,090	\$80,000
MODC \$	\$152,486	\$152,486

This category is where differences in estimation philosophies become most apparent. From TRMM experience, I would expect to finish Phase B with the level of support listed by [REDACTED] (41 FTE), but would ramp up from Phase A levels. This would result in a recommendation of 38 FTE or 67665 staff hours.

ACS – (7 FTE) consistent with TRMM formulation

Power (4.1) – In addition to power design and subcontract monitoring for power system electronics, solar arrays and batteries, this WBS function also manages dc/dc converter design for the IEM. TRMM numbers for this stage of the project were 1.5. With the assumption that the [REDACTED] may be less efficient, 2.5 FTEs or 4440 hours would be acceptable

Mechanical (2.4 FTE) – consistent with TRMM formulation

Thermal (.6 FTE) – this allocation is somewhat light when compared to TRMM, but is acceptable because this function is only covering spacecraft thermal, not instruments, as TRMM did.

Rf (7.6) – As a comparison, TRMM utilized less than 1 FTE for formulation of an Rf system. We could do this because the systems were “off the shelf”. I would expect higher numbers for STEREO, as the system needs modification for our mission, but these numbers reflect the development of a new Rf system, not a heritage design with Contour shared design refinement. They also trend more towards my expectations for implementation versus formulation. My recommended number for this function is 5328 staff hours, or 3 FTE.

IEM (8.4) - Typically I would expect an FTE per function, or card in a box of this type, or at most 6 FTEs (10658 staff hours) for this function during Phase B. In addition, this is, as mentioned for Rf and power, a heritage design from Contour. I am expecting the PCI bus (motherboard?), command & telemetry card, solid state recorder and remote interface units to be virtual copies of TIMED. Modifications, if any, would already be reflected in Contour designs.

Travel (\$122K) represents approximately 61 trips. This is a little on the heavy side, the equivalent of 5 people traveling cross country every month. This could reasonably be cut to 40 trips.

#### **WBS 400** – Spacecraft integration and test

	Proposed	Recommended
Staff Hours	10671	8895
Travel \$	\$19,149	\$8000
MODC \$	\$15,695	\$15,695

Recommendation reduces the [REDACTED] estimate by 1776 hours, or 1 FTE. This is because [REDACTED] utilizes the same ground system for both I&T and mission operations, sharing of resources between the two functions. Also, I felt that the emulator work of WBS 200 also shared resources. The emulator design includes essentially a spacecraft simulator plus a ground system front end – two pieces of EGSE that WBS 400 and 700 are interested in. The choice to remove from this WBS category vs. 700/200 was strictly arbitrary.

Travel was somewhat troubling to me for this group, with approximately 9.5 trips during the year. Nothing in the proposal description justifies this amount of travel. This group is writing integration and environmental test plans, establishing EGSE displays and ground system configurations. I would anticipate some trips to instrument facilities and perhaps a vendor visit for MOC systems. This would translate to 4 trips for the group.

#### **WBS 500** - Launch Checkout and Orbital Operations

Appropriately, no hours were proposed in this category

**WBS 600** – Science and Outreach

	Proposed	Recommended
Staff Hours	2664	888
Travel \$	\$6,197	\$6,197
MODC \$	\$5,080	\$5,080

The \$430K proposed for science and outreach is not a good reflection of tasks proposed. The proposal calls for 1.5 full time equivalent (FTE) senior scientists. Far more than is required to support a project team that already consists of four principal investigators and a project scientist. In addition, I object to the standard application of Miscellaneous Other Direct Costs (MODC). As a straight labor charge, without an indication of what these two scientists need additional funding for, I cannot accept that charge.

Travel – Scientists will be supporting the GSFC team at conferences throughout the world. Travel is appropriate.

Miscellaneous Other Direct Costs – I understand that this estimate is simply based on a formulation, but in this WBS element, it is inappropriate. This function describes consultative support from [REDACTED] scientists for the mission. I have no expectations of their requiring any material costs at all during Phase B.

**WBS 700** – Prelaunch ground Data system/Mission Operations System Development

	Proposed	Recommended
Staff Hours	3722	3722
Travel \$	\$7,361	\$7,361
MODC \$	\$6,033	\$6,033

Travel covers trips to DSN and appears appropriate.

**WBS 800** – Mission Operations and Data Analysis (MO&DA)

No hours were proposed in this category, reflecting the lack of work expected in phase B.

**WBS 900** - Education and Outreach

	Proposed	Recommended
Staff Hours	370	370
Travel \$	\$447	\$447
MODC \$	\$366	\$366

Minimal costs reflecting the support of the STEREO website. This website is utilized by spacecraft and instrument teams for coordination of specifications, ICDs, and other design and schedule information. One third of an FTE is appropriate for this labor category.

### General Clarifications to Proposal

Electrostatic Cleanliness - [REDACTED] states that the requirement of 1 V differential between any two points on the spacecraft imposes "significant baseline design changes". While it is apparent that the current baseline design does not meet this requirement, the implication that the requirement has changed is incorrect. This requirement has appeared in the mission requirements document provided during the PrePhase A and Phase A studies. In addition, GSFC project has provided verbal and email reminders of this recognizably difficult requirement.

[REDACTED] recommends that GSFC carries contingency of roughly 5%. I find this a somewhat unusual and innovative way of not increasing proposal value while covering a perceived need for contingency. I feel that the costs listed above are reasonable for a Phase B effort and reflect phase B efforts performed in the past. The Project will not be carrying additional contingency.

[REDACTED]  
[REDACTED]

STEREO Mission Manager

[REDACTED]  
[REDACTED]

Solar Terrestrial Probes  
Program Manager